

# Promoting Active and Sustainable Commuting: A Tool for Analysing Location-specific Conditions and Potentials for Walking, Cycling and Public Transport

Yingwen Deng<sup>1</sup>, Dagmar Lahnsteiner<sup>1</sup>, Thomas Prinz<sup>1,2</sup>

<sup>1</sup>Research Studios Austria Forschungsgesellschaft mbH, Austria

<sup>2</sup>Universität Salzburg, Austria

## Abstract

Active and sustainable commuting has a positive impact not only on the environment but also on individuals' health. A shift from using unsustainable motorized transport modes to active and sustainable alternatives (cycling, walking and public transport) is desirable. To enable such a shift, it is important to raise public awareness and to call for joint efforts by individuals, employers, planning practitioners and decision-makers. In the ActNow research project, a tool was developed which provides location-specific information vital for promoting active and sustainable commuting. Applying GIS methods, heterogeneous data were analysed and integrated into a 500-metre raster. This raster is embedded in a web application, which provides users with a holistic view of commuter traffic, the accessibility of infrastructure, as well as the potentials, strengths and weaknesses at locations of interest for active and sustainable forms of commuting. The tool provides planners, traffic associations and mobility consultants with evidence that can support them to achieve improvements in traffic, the environment and public health.

## Keywords:

active and sustainable mobility, commuting, web application

## 1 Introduction

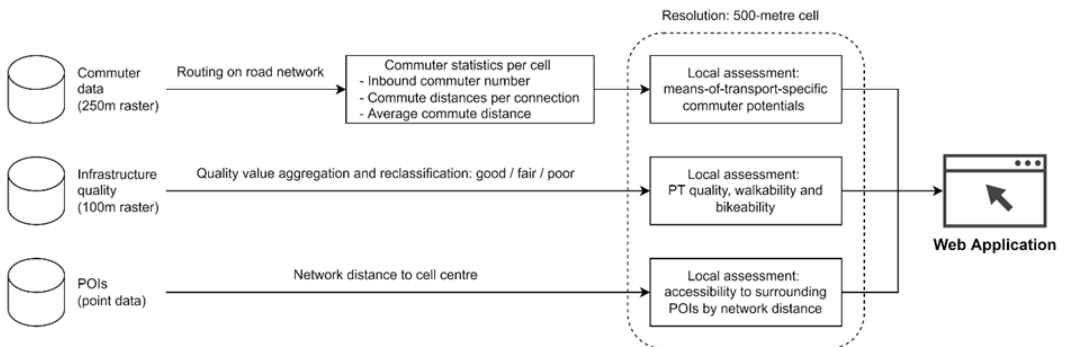
The promotion of active and sustainable mobility has multiple positive impacts on people's daily life, at individual and societal levels. By walking and cycling for single trips or in combination with public transport (PT), more physical activity is brought into people's daily routines and using private motorized transport is reduced (Gerike et al., 2016). Active forms of mobility support the objectives of improving public health (Pucher, Buehler, Bassett & Dannenberg, 2010), transport systems, the climate and the environment (Pisoni, Christidis & Navajas Cawood, 2022). However, enabling such a modal shift is dependent on multiple factors, such as the quality of the active mobility infrastructure, the feasibility and convenience of intermodal travel (Gebhardt et al., 2016), and individuals' attitudes and motivations. As,

additionally, employers can play an important role in promoting active and sustainable transport alternatives among employees (DeHart-Davis & Guensler, 2005; Van Malderen et al., 2012; Vanourivespi et al., 2010), joint efforts by individuals, employers, planning practitioners as well as decision-making authorities are needed.

The research project ActNow aims to make the potential of active and sustainable mobility and the resulting benefits more visible to all these groups. Digital tools and consultation processes were developed to demonstrate optimal active and sustainable commuting to specific sites, and to raise awareness of the impacts of the individual's mobility behaviour on their health and the environment. The focus of this paper is to introduce the web tool (*Standortumfeldtool*) which provides an overview of a user-selected location in terms of its commuter traffic and the accessibility of its infrastructure. The tool also presents potentials, strengths and weaknesses at locations of interest regarding active and sustainable commuting in the form of walking, cycling and public transport. The tool could serve in evidence-based decision-making for planners, transport associations and mobility consultants in providing tailor-made solutions for specific areas and stimulating active and sustainable commuting.

## 2 Data Analysis and Integration

In creating the tool, data from heterogeneous sources (see Table 1) are used. After analysis, in order to make the data accessible as a whole, the results are unified into raster format and embedded in a web application (Figure 1).



**Figure 1:** Workflow for data integration and processing.

Data on commuter traffic and infrastructure qualities, which together serve as the basis for this tool, are available as raster data in mixed resolutions. Various resolutions are therefore chosen for the analysis and the results integration. The analysis of the location environment uses the highest available data resolution – that is 250 m for commuter data, and 100 m for infrastructure qualities. The results are then aggregated into 500-metre cells for integration into the tool. These cells can be selected as potential locations for companies or areas of interest

for development. Location-specific information for the selected cells that supports decision making is visualized in the application.

**Table 1:** Data Source and Description

Data	Source	Description
<b>Commuter data</b>	Pendlerbeziehung aus der Abgestimmten Erwerbsstatistik – Pendler 2018 (Statistik Austria, 2023a)	Includes origin (place of residence) and destination (place of work/school) on a raster basis and their corresponding numbers of commuters
<b>Infrastructure quality</b>	PT Quality: developed by Research Studios Austria, iSPACE based on ÖV-Güteklassen ( <i>Die österreichweiten ÖV-Güteklassen – Rahmen, Struktur &amp; Beispiele</i> , 2022)	Raster-based categorization based on indicators of PT service quality. The classes associate the service quality of stops with the pedestrian accessibility of the stops
	Walkability and Bikeability: developed by Z_GIS (Department of Geoinformatics, University of Salzburg)	Raster-based representation of infrastructure quality and of the physical environment for pedestrians and cyclists (factors such as local topography, obstacles, etc. are considered)
<b>POIs (Point of interest)</b>	Land Salzburg, OpenStreetMap, Salzburger Verkehrsverbund	Infrastructure with relevance for active and sustainable mobility / destinations for accompanying children: PT stops, bike parking, bike renting/sharing, e-charging stations, car sharing, parking places, schools and childcare facilities
<b>Road network</b>	GIP ( <i>Standardbeschreibung der Graphenintegrationsplattform (GIP) Österreich</i> , 2022)	Integrated road and path network
<b>Raster</b>	Regionalstatistisches Datenangebot (Statistik Austria, 2023b)	Regional statistical raster units (250 m, 500 m)

The analysis comprises four modules: routing commuter connections, modelling commuter potentials, modelling strengths and weakness regarding active and sustainable mobility, and calculating network distances to nearby POIs.

## 2.1 Routing commuter connections

As a basis for further modelling, a route was generated for each connection (origin and destination pair) in the commuter data. The route distance was then calculated based on road

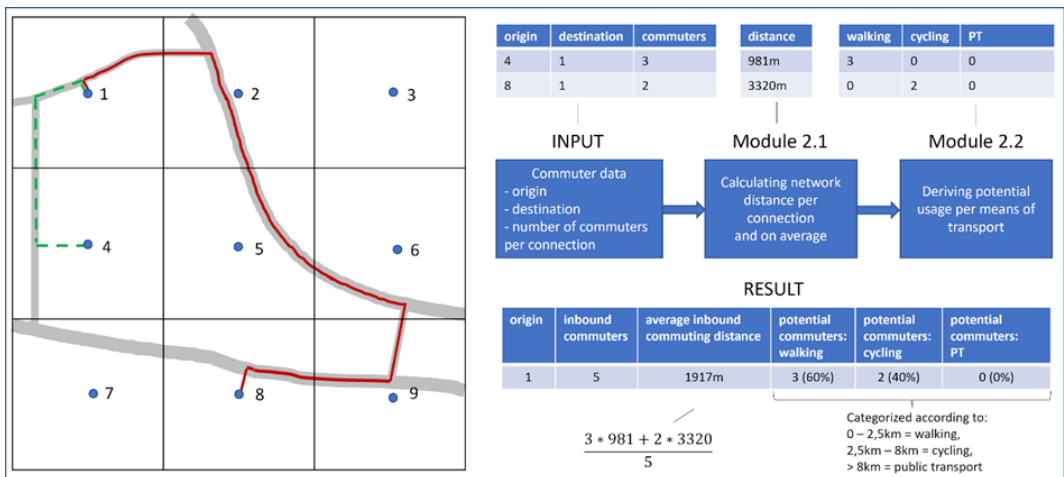
and path networks. The number of commuters per grid cell was linked to the network distances per connection. Thus, a regional statistical raster was created that provides information for each 500-metre cell regarding its number of inbound commuters, the commuters' origin cells, and estimated commute distance (Figure 2).

## 2.2 Modelling potential usage per means of transport

To classify commuters according to their commuting distance, and thus to generate outputs for the potential usage of various individual means of transport, three distance categories were created based on the following assumptions:

- Minimum 10 minutes of physical activity is required to achieve a beneficial effect on health (WHO, 2010)
- 30 minutes' walking/cycling is the acceptable maximum for active commuting (Martin, Panter, Suhrcke & Ogilvie, 2015)
- Average travel speeds that lead to a potential positive health effect are: walking = 5 km/h, cycling = 16 km/h

The relative numbers of commuters per mode of transport are calculated according to commuting distance, with a potential modal split for the commuting routes to any company location (500-metre cell) in the study area: 0 – 2.5 km = walking; 2.5 km – 8 km = cycling; > 8 km = public transport (Figure 2).



**Figure 2:** Illustration of data analysis modules 'routing commuter section' and 'modelling potential usage per means of transport', with example raster cells.

### 2.3 Modelling strengths and weaknesses for active and sustainable mobility

The modelling of raster-based strengths and weaknesses for promoting active and sustainable mobility is built on the output datasets from the GISMO project (Loidl et al., 2018). In these datasets, PT quality, and the walkability and bikeability of a location (100-metre cell) are rated with different indices. The index values are classified as ‘good’, ‘fair’ or ‘poor’ to identify the strengths and weaknesses of the three transport modes at the same location. The results are then aggregated into 500-metre cells.

### 2.4 Calculating network distances to surrounding POIs

To determine the accessibility of relevant POIs in the vicinity of the selected location, distances are calculated based on networks. For each location, the centre of its raster cell is used as the starting point. Since it is common for commuters to coordinate their commuting with their care duties (e.g., accompanying children to school, picking them up from kindergarten, etc.) (Soder & Peer, 2018), network distances to infrastructures such as school and childcare facilities are included in the calculation.

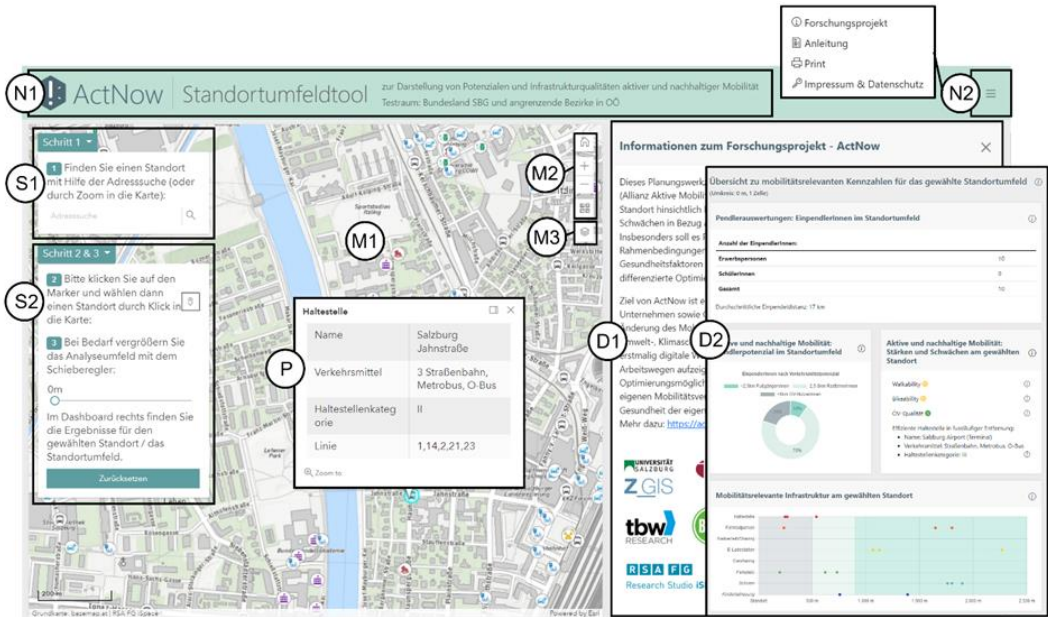
## 3 Interface and Use Cases

To make the analysis results easily accessible and explorable for our target groups, a straightforward decision-support web application was developed. This application provides a holistic view of commuter data in combination with the quality of infrastructure at a location of interest, thus helping to promote active and sustainable commuting. The following section introduces the application’s interface, use cases regarding different user groups, and the technical implementation of the application.

### 3.1 Interface

Figure 3 provides an overview of the application’s user interface. The interface can be divided into three sections: navigation bar, interactive map and dashboard. The navigation bar includes the header (Figure 3, N1) and a drop-down menu (buttons for displaying project information, user guide and print tool, as well as indications regarding copyright and data privacy) (N2). The map section includes a map view (M1), map controls (M2), layer list (M3) and location selector (S1, S2). In map view, a raster of the analysis results, municipality borders and POIs are displayed, together with a base map of Austria. The POIs are marked with different icons according to their categories. Clicking on an icon gives users access to further details for the POI in a pop-up (P). Map controls include a home button for resetting the map extent, a zoom control, and a base map gallery. In the layer list, visualized POI categories are indicated. The location selector allows users to explore the potential and infrastructure qualities concerning active and sustainable mobility in an area of interest. It has two panels. In the first (S1), users

navigate to the location of interest, either by using the address search widget or by zooming directly in on the map. The second panel (S2) allows users to select a single raster cell in the map and its vicinity; using the slider, the user can define the radius of the surrounding area. Dashboard contents are dynamic and respond to different user interactions. When the application is freshly loaded, a panel (D1) presenting an introduction to the research project appears. When an area of the map is selected, the analysis results concerning active and sustainable commuting are provided in multiple panels (D2) in the dashboard.

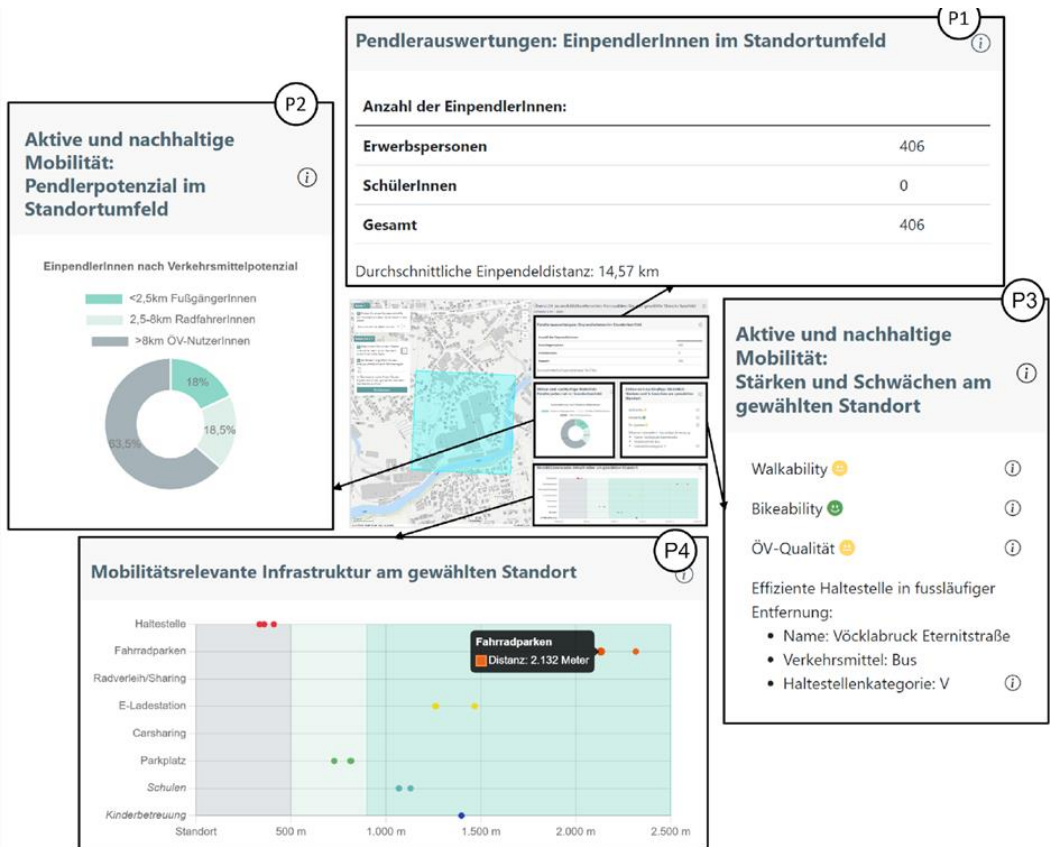


**Figure 3:** User Interface: header (N1), drop-down menu (N2), map view (M1), map controls (M2), layer list (M3), location selector (S1, S2), pop-up window (P), dashboard – project introduction panel (D1), dashboard – results visualization (D2).

### 3.2 Use cases

The prototypical implementation of the project was conducted for the entire province of Salzburg and its adjacent districts in upper Austria (Braunau, Vöcklabruck and Gmunden). Figure 4 shows information provided in the dashboard when an exemplary location in Vöcklabruck is selected. The table in the first panel (Figure 4, P1) shows information about inbound commuters in the vicinity of the selected location. Commuters are categorized into workers and students. In this case, 406 workers commute to the location. Their average commuting distance is 14.57 km. The pie chart (P2) represents the proportion of inbound commuters who could potentially use other means of transport for their commute. We can see that the majority of inbound commuters travel more than 8 km, which represents a high potential for PT usage. The strengths and weaknesses in terms of commuting modes (walking,

cycling and PT) in the selected area are indicated in the dashboard (P3) by emoticons, and more details on PT services are given. The point chart in the last panel (P4) shows the distribution of POIs (the same categories as those shown in the map view) in the surrounding area. The chart is divided into zones that represent travelling distances for the various commuting modes with their respective health benefits.



**Figure 4:** Information panels in the dashboard when a location in Vöcklabruck is selected: inbound commuter volume (P1); potential usage per means of transport by inbound commuters (or potential modal split) (P2); strengths and weaknesses of the selected location for various commute options (P3); infrastructure distribution (P4).

Three use cases can be defined according to the target groups. For infrastructure planners, this application can help in identifying commuting hotspots that require infrastructure improvement to support active and sustainable mobility. At the example location (Figure 4), 36.5% of inbound commuters (148 commuters) have the potential to use unmotorized travel modes. However, the surrounding environment is not pedestrian-friendly and it has few bike-parking options within walking distance of the destination, which indicates that the walkability of the area needs to be improved, as does the availability of places to park bikes. The tool can

also reveal where improved PT is needed. These are places, such as the example location, with a high number of potential PT users but where PT services are infrequent. With follow-up investigations, improvements can target existing problems (e.g. poor accessibility to service, insufficient frequency of buses, etc.). Employers in conjunction with mobility consultants can target the needs of their employees according to the information provided in the dashboard, and the obstacles that prevent choosing active and sustainable commuting modes can be revealed. In this example, employees' average commuting distance is 14.57 km (63% of them travel over 8 km). The distance itself is a major barrier for commuters to switch to unmotorized mobility. However, the PT quality is less than satisfactory. Based on these facts, employer-driven measures such as adjusting work schedules or encouraging car-pooling should be considered.

### 3.3 Implementation

The implementation of this web application is in the front-end. Data layers were published as an ArcGIS map service and then added as a feature layer to the application (ArcGIS Enterprise, 2022). The user interface and user interactivities were implemented using HTML, CSS and JavaScript, with the support of additional libraries including Bootstrap and Bootstrap Icons (Bootstrap, 2022). ArcGIS Map SDK for JavaScript (ArcGIS Developers, 2022) was used to access data from the published map service, which is a web API that allows the display, querying and filtering of data in the application. The queried and filtered data are visualized in the dashboard charts using the ChartJS library (ChartJS, 2016).

## 4 Conclusion

In this paper, we introduced the location analysing tool (*Standortumfeldtool*) developed within the ActNow research project. The tool is a web application for the exploration of site-specific information on commuter traffic, accessibility of infrastructures, and potentials, strengths and weaknesses for active and sustainable commuting. The paper describes the aims of the application, data analysis and integration, and the user interface. Through use cases focusing on specific user groups, we demonstrated how the application could serve as an evidence-based decision-supporting tool for planners, transport associations, mobility consultants and other relevant parties to create spatially optimized possibilities for active and sustainable commuting. The tool provides information on the quality and accessibility of infrastructures that are vital for active and sustainable commuting. Combining data on commuter traffic and commuting distances enables the evaluation of different areas regarding the choice of transport mode. The area surrounding a location can be assessed with regard to its potential for active forms of mobility, while locations to which people commute (e.g. companies, development areas) with high potential but very limited infrastructure can also be identified and thus improved.



## References

- ArcGIS Developers. (2022). ArcGIS Maps SDK for JavaScript - Overview. Retrieved from <https://developers.arcgis.com/javascript/latest/>
- ArcGIS Enterprise. (2022). Map service. Retrieved from <https://enterprise.arcgis.com/en/server/latest/publish-services/windows/what-is-a-map-service.htm>
- Bootstrap. (2022). Build fast, responsive sites with Bootstrap. Retrieved from <https://getbootstrap.com/docs/versions/>
- ChartJS. (2016). Chart.js: Open source HTML 5 Charts for your website. Retrieved from <https://www.chartjs.org>
- DeHart-Davis, L., & Guensler, R. (2005). Employers as mediating institutions for public policy: The case of commute options programs. *Policy Studies Journal*, 33(4), 675-697.
- Gebhardt, L., Krajzewicz, D., Oostendorp, R., Goletz, M., Greger, K., Klötzke, M., . . . Heinrichs, D. (2016). Intermodal Urban Mobility: Users, Uses, and Use Cases. *Transportation Research Procedia*, 14, 1183-1192. doi:<https://doi.org/10.1016/j.trpro.2016.05.189>
- Gerike, R., de Nazelle, A., Nieuwenhuijsen, M., Panis, L. I., Anaya, E., Avila-Palencia, I., . . . Götschi, T. (2016). Physical Activity through Sustainable Transport Approaches (PASTA): a study protocol for a multicentre project. *BMJ Open*, 6(1), e009924. doi:[10.1136/bmjopen-2015-009924](https://doi.org/10.1136/bmjopen-2015-009924)
- Loidl, M., Butzhammer, A., Castellazzi, B., Prinz, T., Wendel, R., & Zagel, B. (2018). Considering spatial factors in promoting active, healthy commuting. *GI\_Forum*, 1, 162-176.
- Martin, A., Panter, J., Suhrcke, M., & Ogilvie, D. (2015). Impact of changes in mode of travel to work on changes in body mass index: Evidence from the British Household Panel Survey. *Journal of epidemiology and community health*, 69. doi:[10.1136/jech-2014-205211](https://doi.org/10.1136/jech-2014-205211)
- Die österreichweiten ÖV-Güteklassen - Rahmen, Struktur & Beispiele. (2022). Retrieved from [https://www.oerok.gv.at/fileadmin/user\\_upload/O\\_\\_ROK-Broschuere\\_Heft\\_10\\_O\\_\\_V-Gu\\_\\_teklassen.pdf](https://www.oerok.gv.at/fileadmin/user_upload/O__ROK-Broschuere_Heft_10_O__V-Gu__teklassen.pdf)
- Pisoni, E., Christidis, P., & Navajas Cawood, E. (2022). Active mobility versus motorized transport? User choices and benefits for the society. *Science of The Total Environment*, 806, 150627. doi:<https://doi.org/10.1016/j.scitotenv.2021.150627>
- Pucher, J., Buehler, R., Bassett, D. R., & Dannenberg, A. L. (2010). Walking and cycling to health: a comparative analysis of city, state, and international data. *Am J Public Health*, 100(10), 1986-1992. doi:[10.2105/ajph.2009.189324](https://doi.org/10.2105/ajph.2009.189324)
- Soder, M., & Peer, S. (2018). The potential role of employers in promoting sustainable mobility in rural areas: Evidence from Eastern Austria. *International Journal of Sustainable Transportation*, 12(7), 541-551. doi:[10.1080/15568318.2017.1402974](https://doi.org/10.1080/15568318.2017.1402974)
- Standardbeschreibung der Graphenintegrationsplattform (GIP) Österreich. (2022). Retrieved from: [https://digitales.wien.gv.at/site/blockchain/?ogd\\_package=c5cca30b-299f-496b-8162-919dca91d94e](https://digitales.wien.gv.at/site/blockchain/?ogd_package=c5cca30b-299f-496b-8162-919dca91d94e)
- Statistik Austria. (2023a). Abgestimmte Erwerbsstatistik. Retrieved from <https://www.statistik.at/ueber-uns/erhebungen/registerzaehlung/abgestimmte-erwerbsstatistik>
- Statistik Austria. (2023b). Regionalstatistisches Datenangebot. Retrieved from <https://www.statistik.at/services/tools/services/regionales/regionalstatistisches-datenangebot>
- Van Malderen, L., Jourquin, B., Thomas, I., Vanoutrive, T., Verhetsel, A., & Witlox, F. (2012). On the mobility policies of companies: What are the good practices? The Belgian case. *Transport Policy*, 21, 10-19. doi:<https://doi.org/10.1016/j.tranpol.2011.12.005>
- Vanoutrivespi, T., Malderen, L., Jourquinspi, B., Thomasspi, I., Verhetselspi, A., & Witlox, F. (2010). Mobility Management Measures by Employers: Overview and Exploratory Analysis for Belgium. *European Journal of Transport and Infrastructure Research*, 10, 121-141.
- WHO. (2010). Global recommendations on physical activity for health. Retrieved from [http://whqlibdoc.who.int/publications/2010/9789241599979\\_eng.pdf](http://whqlibdoc.who.int/publications/2010/9789241599979_eng.pdf)